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Spine

X-ref For other Roundups in this issue that cross-reference with Spine see: *Children's orthopaedics Round-ups 5 & 6.*

Failure in retrieved magnetically controlled spinal rods

■ Magnetically controlled growing rods offer a high tech, mechanical alternative to repeated rod-lengthening operations, and are gaining traction in the treatment of the growing spine. The potential benefits are clear: fewer operations and thus reduced surgical costs in the long term, reduced morbidity from surgical site infections and a reduced psychological impact on young patients. These promised benefits, however, may not be materialising, with sporadic reports of rods failing to elongate or fracture. These authors from **London (UK)** have retrieved and analysed nine magnetic rods that were explanted for differing reasons – a fractured actuator pin, skin discoloration, scoliosis progression, and in preparation for final fusion.¹ The explanted rods were all investigated with radiographs and, in two cases, the implants were sectioned and analysed with micro-CT. The key findings were that a third of the rods had failed due to pin fracture and this was associated with significant corrosion of the internal mechanism. The authors propose a mechanism of failure that involves fluid ingress between the rod and the external shell, as well as a build-up of corrosive debris that increases friction within the device, reducing its capacity to distract, and leading to

fracture of the actuator pin. Although this explant study involves very small numbers, the authors suggest that debris build-up should be considered when rods fail to distract. Several questions remain unanswered: do certain patient factors or distraction techniques increase the risk of pin fracture and does this metal debris have a long-term deleterious effect?

Re-operation following instrumented lumbar spinal fusion

■ A recent NHS initiative entitled Getting It Right First Time (GIRFT) is aimed at improving patient outcomes by standardising care and optimising treatment pathways and, in part, by avoiding unnecessary re-operations. However, unlike hip and knee arthroplasty where early revision surgery is considered a failure of initial treatment, further spinal surgery can be inevitable and does not necessarily represent poor initial care. The authors of this study from **Tampere (Finland)** have examined the re-operation rate and indications for re-operation following lumbar spinal fusion specifically, which is becoming increasingly relevant to all concerned with the GIRFT initiative, bundled payments and loss of income from re-admissions.² The authors report the outcomes of a total of 433 consecutive patients who underwent lumbar spinal fusion in their unit. The most common indication was degenerative spondylolisthesis and mean follow-up was 3.9 years. Within this timeframe, 81 patients had undergone at least one re-operation and there was a

cumulative re-operation rate of 12.5% at two years, rising to 19.5% at four years. The most common indication for re-operation was adjacent segment pathology (8.7% at four years), while other indications included early (< one year) and late (> one year) instrumentation failure at 4.4% and 2.9%, respectively. The rate of other acute complications (such as haematoma/deep wound infection/new neurological deficit or implant malposition) that required re-operation was low at 2.5%. These sorts of studies are becoming more and more important as they underline the mixed causes of re-admission and failure. For the clinician, this study provides a useful guide when informing patients of the risks of surgery during the consenting process and a reasonable standard against which to audit outcomes. For healthcare commissioners, it demonstrates that re-operation in spinal surgery needs to be factored in to funding formulas and that re-operation following fusion is a predictable sequela for a number of patients and not always a sign of failure.

Proximal junctional kyphosis

■ Proximal junctional kyphosis (PJK) is the most common mechanism of adjacent spinal segment failure following instrumented spinal surgery, and is a source of great frustration for the deformity surgeon, and disappointment for the patient. It occurs when the sagittal Cobb angle is > 10° above an instrumented fusion and is therefore an iatrogenic complication often associated with large deformity

corrections. Two studies worthy of comment in this edition of 360 have attempted to quantify the risk factors of PJK so that it can be avoided. The first of the two articles, a multicentre study from **Lyon (France)**,³ set out to investigate the factors predictive of PJK, by undertaking a thorough analysis of radiological parameters present in 250 patients following adult deformity surgery. They compared four different formulas of recognised geometric relationships involving spinal parameters, such as lumbar lordosis (LL), thoracic kyphosis (TK) and pelvic incidence (PI). They used pre-operative and immediate post-operative films in order to establish the potential predictive value of each for PJK. Patients were followed up clinically and the prediction was then compared with actual occurrence of PJK. There was a 25.5% incidence of PJK within the follow-up period. Essentially, only two of the examined methods actually predicted PJK: first, if the global sagittal alignment (GSA = LL + PI + TK) was > 45° (19.9% vs 29.9% when > 45°); and second, if the theoretical and actual apex of lordosis did not match up (13.5% vs 38.9%). The latter method was based on Roussouly's curve types and the theoretical apex was L3 if PI > 55°, and L4 if PI < 55°. In the second paper on the same topic, originating from several centres in the **USA**, the investigators focused on a number of previously identified risk factors.⁴ Their study reported the results of 252 patients, all with adult spinal deformity (ASD), with two years of clinical follow-up available. The



authors then used previously identified radiological measures to evaluate their potential predictive value for PJK. The measures evaluated included pelvic incidence, lumbar lordosis, pelvic tilt, and inclination of the proximal end of the construct. In this series, a higher rate of PJK was seen at two years, and there were greater changes in lumbar lordosis and thoracic kyphosis in those patients who then went on to develop PJK. This study confirmed several previously known risk factors: greater lumbar corrections; a greater change in thoracic kyphosis; and use of instrumentation to the lower thoracic region (as opposed to the upper thoracic region) were associated in these patients with an increased risk of PJK. In addition, they demonstrated that patients with more posteriorly inclined instrumentation were also at greater risk of PJK in the lower thoracic region, and the authors suggest that perhaps better rod contouring was the solution. For the deformity surgeon, these are all factors to consider during surgical planning, but knowing what factors might be important in avoiding PJK and actually achieving them may prove harder.

Pulmonary function in adolescent idiopathic scoliosis and surgical approach X-ref

■ The effect of scoliosis surgery on pulmonary function has been widely reported and, despite the clear importance of understanding whether posterior or anterior approaches are safer and more

effective, sadly the literature is somewhat conflicted. There are numerous flawed papers presenting contradictory results, ranging from reduction to improvement of pulmonary function. Given the large number of studies in the literature without consensus, clearly the time was right for a systematic review, which is exactly what these authors from **Charlottesville, Virginia (USA)** have achieved.⁵ The authors undertook a thorough literature search and were able to include 22 studies in their results. They performed analyses of a variety of different potential treatment strategies by surgical approach (anterior +/- thoracotomy/posterior) and procedure (instrumented fusion +/- thoracoplasty). The outcome of this review is surprisingly clear. Anterior surgery is associated with a moderate to large reduction of pulmonary function at three months, regardless of technique (video-assisted *versus* open). However, this effect normalises by two years. Posterior spinal fusion is associated with a small to moderate increase in pulmonary function at two years. The effect here is not sufficiently significant to recommend one approach over another. Nonetheless, it is clear that posterior surgery is better if taken purely from the perspective of pulmonary function.

Improving percutaneous pedicle screws

■ Minimally invasive spinal instrumentation relies on accurate positioning of the pedicle screws, which involves percutaneous placement aided by either an image intensifier or a navigation system. In most cases, units are simply using an image intensifier. This percutaneous approach is considered by some to be safer, and with a less steep learning curve for training spinal surgeons than the free-hand open techniques. One potential downside, however, the rate of facet joint violation (especially at the most cranial level of instrumentation), and this is often overlooked. Facet joint injury in this way is likely to

cause adjacent segment disease. This group from **Baltimore, Maryland and Philadelphia, Pennsylvania (USA)** investigated two alternate techniques for percutaneous screw placement - the oblique approach, or owl's eye trajectory (OET), and the anteroposterior technique with a lateral-to-medial trajectory (LMT) – with the aim of establishing which is safer from the perspective of maintaining facet joint integrity.⁶ The investigators placed screws in cadavers using one of these two techniques. Sides were randomised between OET and LMT, with the contralateral side receiving a screw placed with the alternative technique. Overall, the surgical team placed 210 screws into 105 spinal levels using both techniques. The screw positions were then analysed afterwards using CT to assess accuracy of placement. Overall, 17 of 105 screws placed with an LMT *versus* 49 of 105 screws placed with an OET violated the facet joint, whereas the medial pedicle wall breach rates were similar between the two techniques. There is clearly an advantage here to the LMT approach, with lower rates of facet joint incursion and similar rates of pedicle breach.

Hospitalisation for sciatica: who is at risk?

■ Sciatica is not just a specialist spinal problem, nor is it necessarily indicative of a serious underlying pathology. Globally, sciatica is the most disabling condition presenting to secondary care, with junior staff fighting against the tide of affected patients. Preventing the growing influx of these patients must rank high on the agenda of our subspecialty, and a large study from **Oulu (Finland)** gives some unique and useful information about who is at risk of sciatica and what factors in their lifestyle are responsible for their presentation.⁷ This is a large study that makes use of a population cohort survey carried out between 1973 and 1976 of 19 518 Finns aged and this 20 years and over. At the time, information

regarding a wide range of lifestyle factors was collected, and every patient was followed up until 2011 using high-quality national hospital discharge databases to look for those who had been admitted to hospital with a coded episode for sciatica. The authors excluded patients as they reached 59 years old and those with a lower back disorder or sciatica prior to inclusion in the original survey. They established that between 1976 and 2011, 363 male patients and 339 female patients were admitted to Finnish hospitals with sciatica, and sought to identify which risk factors were responsible for these admissions. The authors showed that for females, being tall, overweight (but not obese), having a self-perceived 'quite good' health status and smoking more than 20 cigarettes per day were all associated with an increased risk of hospitalisation for sciatica. For males, the risk factors were subtly different and included self-perceived 'poor' or 'average' health, smoking, heavy physical work and sedentary leisure time. For both genders, being a medical professional or working in industrial manufacturing contributed. This study caught our eye because of the scale of the project and the quality of the follow-up data, although of course it is unable to show causation. Multiple confounding factors could contribute to the admission of patients with sciatica, not least of all the development of rapid MRI and improvements in analgesia. However, we can now, with some authority, begin to identify those with an at-risk lifestyle and direct them appropriately.

Identifying injury to the posterior ligament complex: not just MRI

■ Spinal injury is always a challenge, and identifying those with significant injury following trauma is a challenge that has undoubtedly benefited from the increased availability of MRI. Despite this improved access, early trauma radiology usually relies on plain radiography and CT to identify injuries and prioritise

their treatment. Does this leave the potential to miss significant ligamentous soft-tissue injuries that can afflict the thoracolumbar junction, rendering it unstable? A group from **Wonju (South Korea)** have reported their own retrospective case series examining the utility of plain radiographs in identifying clinically significant ligament complex injuries that would influence the surgical treatment of trauma victims.⁸ They propose the interspinous distance ratio (ISDR) as a sign of ligamentous instability; they define this as the ratio of the distance between the spinous processes of the injured vertebra and the subjacent or superjacent vertebra, and the interspinous distance at an adjacent motion segment. They then go on to measure the ISDR in 153 patients who underwent spinal stabilisation for trauma. Patients were excluded if they showed any signs of tumour, infection, vertebral fragility fractures or fractures to the adjacent thoracic or lumbar motion segments. The mean age of patients was 47 years, and L1 was the most commonly injured vertebra. When measured using a plain lateral radiograph in the right down decubitus position, an ISDR of 120% was clinically detectable and yielded a sensitivity of 81%, specificity of 76% and an accuracy of 79%. This compares rather favourably with

the published figures for a 1.5T MRI scanner of sensitivity 79.2 to 100 and specificity of 56 to 100. Perhaps the most useful application of this technique is likely to be in the indeterminate injuries previously defined by Alexander R. Vaccaro, rather than in those patients whose injury (or lack of injury) is clear. In either case, this technique is an extra tool in the detection of significant thoracolumbar spinal injuries.

Simple but great: where to put fusion cages?

■ Sometimes a paper crosses our desks here at 360 that addresses a question that we can't believe has not been answered before. This paper from **Auckland (New Zealand)** is one such study.⁹ In it, the authors describe where to put paired interbody fusion devices, to reconstitute lumbar lordosis. We know that most lumbar pathologies are associated with regional hypolordosis, and that reconstructing the sagittal profile of the lumbar spine is important in maximising functional outcomes. An analysis of 83 patients treated with a single-level posterior lumbar interbody fusion (PLIF) with posterior instrumentation has been undertaken, and the patients' self-reported pain and disability recorded, with a view to describing the optimal position of paired polyetheretherketone (PEEK) interbody fusion devices. The results suggest that cages should be

positioned with their midpoint anterior to the midpoint of the vertebral endplate. This is somewhat at odds with those who have avoided this location due to the risk of cage subsidence. To support their stance, the authors showed that positioning the cages accordingly led to an increase of nearly 6° in lordosis maintained at one year, with persisting improvements in patient-reported pain and disability scores. The maintenance of the cage's centre of rotation position anterior to halfway along the superior endplate of the inferior vertebrae was moderately correlated to the lordosis gained. When considered alongside posterior osteotomy and instrumentation, this was likely to lead to a much greater anatomical correction of lumbar lordosis. Groundbreaking? Seemingly not, yet these findings have not been described before. This new information, however, may explain why unilateral facetectomy in transforaminal lumbar interbody fusion (TLIF) techniques does not universally improve patient outcomes, and why wide posterior osteotomy with anterior cage placement is most likely to improve patient symptoms. Sometimes the simplest studies are the best, and certainly this paper has a direct bearing on our clinical practice.

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Trauma

X-ref For other Roundups in this issue that cross-reference with **Trauma** see: **Hip Roundup 7; Wrist & Hand Roundups 4, 7 & 8; Children's orthopaedics Roundup 3 & 7.**

Shortening and healed mid-shaft clavicular fractures X-ref

■ There have been a good number of randomised trials now looking at shortening and the clinical outcomes of shoulder function following

clavicular fractures, and, in particular, the beneficial effects or otherwise of clavicular fracture fixation on eventual shoulder function. Although the studies themselves appear to be somewhat conflicting on first glance, the results are actually remarkably similar, with the differences in conclusion essentially being based on differences of reporting and interpretation of these remarkably similar results. What is different is the perception of

malunion and nonunion as a study event, and how these are dealt with. It is very timely, therefore, to see this study from **Edinburgh (UK)** evaluating the impact of clavicular shortening on patient outcome.¹ Essentially, this study is questioning the widely held view that non-operative treatment with shortening can negatively impact upon outcome. The data used in this study were collected as part of a multicentre

prospective randomised controlled trial of open reduction and plate fixation compared with non-operative treatment for acute displaced mid-shaft clavicular fractures. The investigators studied as a cohort the 48 patients who were randomised to non-operative treatment and had healed by one year. Of note, 17% of patients (16/105) in the original study who were treated non-operatively developed a nonunion, 13 patients

